Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/683
SWEDEN
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

Theory and Applications of Heterogeneous Methods for Heavy Water Lattice Calculations

A. Jonsson [1], P.-E. Ahlström [2], P. Lindgren [3], G. Näslund [1], T. Skardhamar [1]

Commonly used methods for overall reactor calculations of reactivity and flux distributions assume that the reactor media can be considered as homogeneous. It has been shown by Galanin that this is a valid assumption for a heterogeneous reactor if the lattice is uniform and the number of fuel elements sufficiently large. For defective or composite lattices containing for example vacant positions, fuel elements of different types or control rods, or if the number of elements is less than 20-30, homogeneous theory may apply less well. To handle these cases a series of heterogeneous computer programmes have been developed at AB Atomenergi. Comparisons with experiments have given some confidence in these methods for treating uniform as well as non-uniform heavy water lattices. The purpose of this paper is to summarize the experience and present status of the work, and to describe how the heterogeneous method has been adapted to heavy water power reactor calculations.

The paper is divided into four parts. Part one outlines the basic theory for a finite cylindrical reactor in the three-dimensional, two-group diffusion theory case. The basis of the heterogeneous method is an analytical solution of the diffusion equation assumed to hold in the moderator separating the different elements of the core. This general solution is subject to boundary conditions on the moderator surface which is taken to consist of an outer boundary in the form of a circular cylinder of finite height, and a number of disconnected inner

1) AB Atomenergi, Stockholm
2) Swedish State Power Board, Stockholm
3) ASEA, Västerås

surfaces, the fuel-moderator interfaces. At the outer boundary the zero flux condition is imposed, and at the inner boundaries extrapolation length type conditions are used.

In part two, different numerical methods for the solution of the basic equations are discussed, mainly in the three-dimensional case. An outline of the existing computer program is given. The numerical method is also briefly compared to the conventional difference technique with respect to calculating time and storage requirements.

In part three, the application of heterogeneous methods for predicting reactivity effects and flux distributions in heavy water lattices is discussed and compared with experimental measurements in the R0 critical facility and the Ågesta power reactor. An outline is given of the accuracy with which present methods can be applied for calculations on both uniform and non-uniform lattices, in particular for determining the reactivity effects and flux distorsions of single and groups of control rods.

Part four describes some applications of heterogeneous methods to design calculations for the Marviken power reactor, including studies of different fuel cycles, different ways of initial loading, and of control rod effects.